

Appendix A : Calculating Spatial Segregation Measures

The spatial segregation measure we used in this study was developed by Reardon and O'Sullivan [1] as spatial alternatives to traditional aspatial measures of segregation. Conventional aspatial measures of segregation like the 'Dissimilarity Index' rely on a much critiqued assumption that tracts or block groups are spatially autonomous, and that residents sharing the same census unit have no proximity to residents outside the unit but are equally proximate to those within their boundaries [1]. In contrast, spatially explicit measures of segregation, such as **Spatial Exposure** (\tilde{P}^*) and '**Spatial Information Theory Index**' (\tilde{H}) factor in the relative location of different groups within the area of interest.

Calculating Spatial Exposure

Spatial Exposure (\tilde{P}^*) first requires the calculation of a spatially weighted group composition of the local environment of each location (for our analysis, this is the census tract) in the region of interest (individual counties in this analysis)

The relative 'exposure' to other residents within the same county is spatially weighted based on the Euclidean distance between each census tract (i.e. a distance-decay effect). We used a negative exponential function to represent a distance-decay effect, where shorter distances between census tracts assumes increased probability of their residents interacting. The weight given to these listings was defined as $w(d) = e^{-\beta d}$, where d is the Euclidean distance in km between the listings' locations, and β is a distance-decay factor. We chose an exponential function because empirical research on intra-urban mobility patterns in cities suggested that an exponential law better reflected the distance-decay effect on individuals' daily activity range [2] and trip length distributions [3] than a power law.

As walking is a mode of travel that provides more opportunities for chance encounters and social interactions [4], and which has been associated with a greater sense of community within neighborhoods [5], we examined available empirical studies that modeled the distribution of walking trips using negative exponential functions. These studies generally pegged the distance-decay factor for walking trips between 0.6 and 2.1 per km. We assumed a rate of decay $\beta = 1.0$, which falls within the range in other studies [6,7]

Effectively, we calculated a 'surface' of information, which gives at each census tract centroid the weighted proportion of the population within its local neighborhood who are members of each defined racial/ethnic groups. This surface of weighted population proportion for each listing's localized environment, **as described above**, is used to calculate \tilde{P}^* . Equation below summarizes how \tilde{P} is calculated

$${}_b(P^*)_w = \int_{q \in R} \frac{\tau_{qb}}{T_b} \pi_{qw} dq$$

Where

π_{qw} = weighted proportion of White individuals within census tract q 's local environment

T_b = Total number of Black individuals within county

τ_{qb} = Total number of Black individuals within census tract

Q = each census tract

Calculating Spatial Diversity

Similar to \tilde{P}^* , \tilde{H} is calculated using the surface of weighted population proportion for each listing's localized environment.

The degree of segregation is measured by taking the spatially weighted group composition of the localized environment of each census tract as described above, and calculating a spatially weighted entropy score (\tilde{E}_p) for each (Reardon & Sullivan, 2004). Given there are four (White, Black, Hispanic, Other) racial/ethnic groups in this analysis, the entropy score for each census tract is calculated as follows:

$$\tilde{E}_q = - \sum_m^M (\pi_{qm}) \times \log_M(\pi_{qm})$$

Where:

M = Number of distinct groups (4 in this study)

m = White, Black, Hispanic, OR Other

π_{qm} = Weighted proportion of m at census tract q

The higher the entropy score, the more diverse the local environment is. The maximum score occurs when all groups have equal representation in the geographic area, such that with 4 groups each would comprise about 25% percent of the area's population.

Each localized environment would then be compared against the overall group composition of the county, to calculate each county's 'Spatial Information Theory Index' (\tilde{H})

$$H = 1 - \frac{\int_{q \in R} (\tau_q \times \tilde{E}_q) dq}{T \times E}$$

Where:

E = E is the overall county entropy of the total population calculated as:
 $-\sum_m (\text{proportion of } m \text{ in county}) \times \log(\text{proportion of } m \text{ in county});$

τ_q = Population density at q ;

T = Total population in county

Both measures are calculated using R package ‘seg’ 0.5-7 [8]

References

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